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0. Summary

The Danish government has set specific goals for setting aside forestland for biodiversity purposes in the form of untouched forests, where no production forestry operations can be undertaken. This report presents and applies a methodology for calculating the costs of such an action in terms of foregone income and other costs for the private forest owner. The results are intended to inform the design of a support grant scheme to be designed and implemented to compensate private landowners for costs of voluntarily setting aside forestland as permanently untouched, which here implies the absence of any management activities.

The report applies the widely acclaimed standard present value approach to calculate present value measures of foregone income net of forest operation costs to the private forest owner. Established models of forest growth and forest operations are applied together with best available data on forest operation costs and forest product prices. These are compared to the realization value of the stands.

The report presents results for three broadleaved forest types based on main forest species, which are Beech (*Fagus sylvatica*), Oak (*Querqus robur*) and Alder (*Alnus glutinosa*). The species are selected as they represent the most common native forest types, and a number of NATURA2000 forest types are associated with these tree species (Council Directive 92/43/EEC). Beech and Alder are assumed to be grown in forest systems applying natural regeneration, whereas Oak is assumed to be grown in clear cutting systems. Results are presented for different ages, different site classes for Beech and Oak, different assumptions about log quality and for different discount rates.

For Beech site class I evaluated at 3% interest rate, we find present values in the range of 73,000 to 173,000 DKK over the stands life. The realization value is always lower ranging from 17% to 85% of the present value, highest when the stand is almost mature. Note, that also in the younger years we see quite high realization values due the natural regeneration system. For site classes of lower productivity, we find a lower range of present values. Because of the low productivity combined with regeneration costs and the relatively high interest rate of 3% we find ratios between present values and realization that are above 100% close to optimal rotation age, but note that these are not common forest types.

Forest stands offered as being set aside for biodiversity purposes might be of poor quality and therefore the report also includes models where all logs are assumed to be of C quality. Here we see that the present values and the realization values decrease considerably compared to forest stands at similar site classes and evaluated at similar interest rates. For Beech site class I, but of C quality, evaluated at 3% interest rate the present values range between 66,000-142,000 DKK/ha, which illustrates the range of possible

compensation needs even for this high site class. We see a large variation in the ratio between present values and realization values ranging from 19% to 93%.

In the case of Oak evaluated at 3% interest rate, we see that the soil expectation value is negative for all site classes due to the long production period and the high establishment costs. Thus, we have assumed a switch to Norway spruce following final harvest is in the calculations of Oak where the soil expectation values are negative. We find present values over the stand life of 21,000-385,000 DKK/ha; highest close to optimal rotation age. For the site class of lower productivity, we find a lower range of present values and also realization values that are consistently lower than the present values. Analogous to the calculations for Beech we also present models of low quality Oak stands where all logs are assumed to be of C quality. The lower quality influences both present and realization values and they are considerably lower compared to the values presented for the same site class and the difference increases with stand age. The present values for site class I evaluated at 3% interest rate range from 15,000 to 253,000 DKK/ha with the ratio between present values and realization values developing from 0% to 92%. Again, this illustrates the range of possible compensation needs even for this high site class if the quality is low.

In the case of Alder evaluated at 3% interest rate we find present values ranging from 42,000 to above 59,000 DKK/ha and that the underlying realization value of the forest stand is always well below present values with a ratio in the range of 29% to 55%. We find that the short rotation age of 60 years and the natural regeneration assumption drive this larger wedge between present value and realization value.

In addition to these results, a sensitivity analysis where all models are evaluated at interest rates of 1% and 2% respectively and results can be seen in the appendices. For Beech, we also include a sensitivity analysis where we assume an accelerated harvest of the over-story mass and these can be found in the appendices as well. We further discuss a number of factors that may influence the present value measures obtained These include stand completeness or crown cover, they include other quality aspects, e.g. bole height, affecting assortments beyond what we have evaluated as well as very old stands. Finally, we point to the option for harvesting parts of the value of in particular older stands, which may reduce costs disproportionately more than biodiversity potentials. Such a practice could be based on an analysis outlining what can likely be removed safely without potential negative impacts on biodiversity, acknowledging what remains unknown about these issues.

1. Introduction

The Danish government has set specific goals for setting aside forestland for biodiversity purposes in the form of untouched forests, where no production forestry operations can be undertaken. Part of these goals will be fulfilled on public and state owned forestland, and parts will be fulfilled on private lands (Miljø- og Fødevareministeriet, 2016). In either case, setting aside forestland will come at a cost in terms of opportunity costs of foregone forestry income. In the latter case, a support grant scheme will be designed and implemented to compensate private land owners for their foregone income and other costs of setting aside forest land as permanently untouched, which here implies the absence of any management activities.

This report applies the well-known and widely used methodological approach of net present value calculations (Jacobsen et al., 2014), which is useful for calculating the opportunity costs of setting aside productive forest as untouched with the purpose of enhancing biodiversity protection. The general method is capital budgeting and opportunity costs are calculated as the present values of foregone income and other costs for the forest owner, related to lost opportunities of future harvest income and forest operation costs.

Available growth and forest operation models are used and adapted for the purpose along with best available data on costs and product prices to calculate present value measures for a set of different forest types (tree species), site classes and stand ages of relevance to the coming actions and scheme implementation. The calculations are structured to enable the subsequent formulation of a new Danish grant scheme, designed to provide incentives for setting aside such forest, while securing that forest owners are not over-compensated. This is done by ensuring transparency in all calculations and furthermore by supplying estimates of realization values alongside the present values.

2. Methodology

Setting aside forestland as untouched with the restriction that no further harvest can take place implies the loss of the future income stream from forestry net of related forest operation costs. At any point in the lifetime of a stand, the value of this net loss can be assessed by estimating the present value of the stand in focus using the appropriate mathematical method and expression as well as suitable models, data and assumptions for the case at hand. This is the overall method taken here, and here we outline the generic principles.

Since Faustmann's 1849 paper on the value of a piece of forest land for perpetual use for forestry and the resulting optimal rotation age, it has been widely acknowledged that prior to the optimal rotation age T the present value V of a forest stand of age t can be determined as:

$$V_t = \sum_{\tau=t}^{T-1} \frac{p_\tau \times m_\tau - c_\tau}{(1+r)^{\tau-t}} + \frac{p_T \times aM_T + V_0}{(1+r)^{T-t}} \quad 1)$$

Here the interest rate for discounting is r, p_τ is the average price of a volume unit at age τ (net of harvesting and transport costs), m is the volume harvested, e.g. as thinnings, at a given age, c is any cost related to e.g. planting and regeneration, tending or other area specific costs. M is the total volume in the stand at a given age, and a is the fraction of M harvested at age T. In a clear-cutting system, we interpret T as the optimal rotation age and all volume is harvested, that is $a = 1$. Following harvesting of all the volume, a new stand is established and just before incurring cost of establishment, the forest land has the value V_0; also called the soil expectation value. Under a system of natural regeneration, we can interpret T as the age where the first regeneration cut is made, and $0 < a < 1$ is the fraction harvested at that time. Then V_0 is the present value of the stand right after regeneration harvest.

It is useful to define also the realization value, R, as the value of harvesting all the volume in the forest stand at a given age, t:

$$R_t = p_t \times M_t \quad 2)$$

Note, that at the optimal rotation age, T, this value R is part of the numerator of the second term in V_t in Equation 1). Because of the optimality of the optimal rotation age, it can be shown that for all ages below the rotation age, R is always strictly smaller than V, provided $V_0 > 0$. As the value of the forest stand is growing faster than opportunity cost of capital and land prior to the optimal rotation age, the present value of income from forthcoming thinnings, the final or regeneration harvest and the new forest stand exceeds the value of harvesting the entire forest stand now, i.e. the realization value R. For forest stands exactly at or older than the optimal rotation age, the optimal decision is to harvest or regenerate the stand

as fast as possible and establish a new stand. For a clear cutting system, the value of this is the realization value plus the value of a new forest stand with the selected tree species:

$$V_{\mathrm{A\geq T}} = p_A \times M_A + V_0 \qquad 3)$$

Provided $V_t > 0$, also this value is strictly larger than the realization value R, which is the first term on the right hand side. A similar expression can be set up for a natural regeneration system, provided the stand is still young and complete enough to be able to regenerate in a way that result in a full and complete stand.

3. Data sources

The estimations will rely on best available data and forest economic models for the analyses. Market prices of outputs are found in market statistics, e.g. the market statistics provided on-line by the Danish Forest Association (www.skovforeningen.dk), and phone and mail interviews gathering additional price information etc. where needed. Cost models for afforestation and natural regeneration, as well as assortment tables for harvested volumes, are based on the most recent compilation of standard models adjusted for general price trends and method development as deemed appropriate (Skovøkonomisk Tabelværk, 2000). All models include only variable costs directly related to the supported activity, i.e. no fixed costs or other irrelevant cost elements are included. All foregone income measures include only incomes that will be foregone and not, e.g. the value of hunting rights (Meilby et al., 2006; Lundhede et al., 2015), which are assumed unaffected by the restrictions on forest harvests. The silvicultural and growth models applied are standard models developed for Danish conditions. As the assessment concerns the valuation of private opportunity costs for Danish landowners, a discount rate of 3% is applied as the base discount rate, but we present sensitivity analyses using also 1% and 2%. Available research suggests equilibrium returns in the range of at most up to 3% for forest investments in Denmark (Thorsen, 2010). Growth models of the different species and sites classes are drawn and adapted from standard models for Danish conditions (Statens Forstlige Forsøgsvæsen, 1979; Holten-Andersen, 1987)

4. Cases to be analyzed

Based on the above method, we set up a series of cash flow models for three forest types and estimate the present value losses associated with setting aside the forest as untouched, as well as the realization value of the standing volume just before thinning or cutting for a range of stand ages.

The forest types modelled and analyzed are:

- Beech forest, where optimal management is based on natural regeneration of Beech
- Oak forest, which is managed in a clear-cut system, often involving species shifts for e.g. conifers when optimal
- Alder forests, typically on wet areas, where forest regeneration is largely based on stump and natural regeneration with Alder.

Within each of these forest types, the estimations will be undertaken for a number of relevant variations in preconditions, including:

- Site classes for Beech (I, III, V) and Oak (I, III)
- Stand age at the time of setting aside
- Quality distribution of logs in Beech and Oak
- Discount rates varying over 1%, 2% and 3%
- Accelerated harvest of the over-story mass for Beech

5. Results

We present the main results for each species in turn, including the sensitivity analyses, and explain the variation along main parameters and stand characteristics.

5.1 Beech

In Table 1, we show the present value (at 3% interest rate) of a Beech forest stand of site class I for a set of different ages along with the underlying realization value of the forest stand – for all cases where it is larger than zero. We see that the present value measure of the stand is always above the realization value and the ratio between the two develops from 17% to 85% when the stand is almost economic mature for starting the partial harvest. We note that the stand is naturally regenerated and therefore the realization value of the early years also includes the value of the leftover over-story of shelter trees. In Table 1 below the regeneration cutting starts at an age of 90 years and the last trees of the over-story are harvested 20 years later, i.e. in year 110.

Table 1: Beech, site class I evaluated at 3% interest rate, with rotation 90/110 years

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value	172,952	179,288	73,310	90,950	100,317	110,445	122,753	137,874	157,262
Realization Value in DKK	142,886	133,934	12,766	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	83%	75%	17%	38%	52%	74%	73%	85%	84%

Similarly, Table 2 and 3 below presents the corresponding results for site classes III and V. The lower productivity of the land is reflected in the lower present value measures of foregone income.

Table 2: Beech, site class III, evaluated at 3% interest rate, with rotation 100/120 years

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value	102,848	107,797	35,196	44,750	52,002	58,322	63,525	69,984	78,538	89,123
Realization Value	87,350	80,660	2,608	12,366	27,237	39,336	48,315	62,668	76,,007	87,267
Ratio	85%	75%	7%	28%	52%	67%	76%	90%	97%	98%

The lower productivity implies that the regeneration costs, which are assumed identical across the three site classes, weighs relatively heavier in the present value measures close to the optimal rotation age. This results in larger fluctuations in the ratio of realization values to present values. For the very low site class, site class V we even find ratios above 100% close to optimal rotation age. We note that these are not common forest types. We also note that for the low site classes the assumed regeneration evidently could be less successful compared to the higher site classes, in spite of the longer over-story phase, which is not reflected in the calculations.

Table 3: Beech, site class V, evaluated at 3% interest rate, with rotation 110/130 years

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value	40,674	41,271	10,177	13,678	17,861	21,778	25,675	27,376	28,795	29,972	29,173
Realization Value	43,202	38,462	0	995	6,659	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	106%	93%	0%	7%	37%	65%	80%	104%	126%	138%	152%

The above tables are based on standard forest product assortments being harvested in thinnings as well as the final harvest. In some cases, forest stands offered up for setting aside as untouched has a significantly lower average quality. To illustrate the consequences of this, we present the results of estimations under the assumption that log volume of the Beech forest is all of C quality. These results are presented in Table 4.

Table 4: Beech, site class I, evaluated at 3% interest rate, with rotation 90/110 years, C quality

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	136,156	142,222	66,407	81,652	87,623	93,364	100,487	109,579	122,134
Realization Value in DKK	113,396	103,131	12,810	35,027	51,606	79,106	81,847	101,913	111,068
Ratio	83%	73%	19%	43%	59%	85%	81%	93%	91%

We see that the present values and the realization values decrease to some extent compared to Table 1. This illustrates the range of possible compensation needs even for this high site class.

In the Appendix (Tables A7 – A9), we present the same results of assuming C quality also in site class III and V. We also show these and all of the above tables in two different versions for interest rates at 1% and 2%. In general, lower interest rates increase the present value of future income foregone. Interest rate does not affect the realization value, however, and therefore the ratio of this relative to present values also decrease substantially for lower interest rates. Interest rates do affect the rotation age, however, and thus the range over which we consider present and realization values.

We also present calculations of a more accelerated harvest of the over-story than in our benchmark case. That is a relatively larger share of the over-story mass is harvested in the initial phase of the regeneration process. These analyses can be found in Appendix A12-A15 for Beech evaluated at the three different interest rates and site classes. Here we show the calculations for site class I evaluated at 3% interest rate.

Table 5: Beech. Site class I, evaluated at 3% interest rate with rotation age 90/110, accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	171,810	153,220	73,636	91,389	100,907	111,237	123,818	139,306	159,186
Realization Value in DKK	147,723	110,550	12,766	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	86%	72%	17%	38%	51%	74%	72%	84%	83%

If we compare the accelerated harvest of over-story calculations to the calculations presented in Table 1 with a 'normal' harvest we hardly see any differences in the present values for the two regeneration regimes and that only the realization values in the early years are affected due to the earlier harvest of a larger part of the over-story. The reason for this is two counteracting effects. The first is the earlier harvest of standing over-story volume which tends to increase present values prior to and the early years of the regeneration phase. The second is a loss in production in the over-story as it quickly becomes more open, which tends to decrease the present values. We note that we do not have a basis for modeling differences in impacts on the regeneration, but again two factors may be in play; increased light and hence growth, but also potentially issues of grass and other competition as well as loss of humidity. These factors also affect the value in opposite directions.

5.2 Oak

For the calculations related to Oak we note that that when evaluated at 3% interest rate, the soil expectation value Oak is negative for all site classes due to the long production period and the fairly high

establishment costs. Hence, we have included the soil expectation value of Norway spruce (*Picea abies*) as the value of the land in future best use in forestry. This assumption is not based on empirical evidence, but rather on the assumption that economic rational choice of tree species for regeneration is to pick a species with highest possible economic return (excluding risk of storm). The soil expectation values of Norway spruce at different site classes and interest rates are presented in Appendix A16-A17. Note, that no risk of storm felling has been included in the calculations of soil expectation values of Norway spruce.

In Table 6 we find the present value (at 3 % interest rate) of an Oak forest stand of site class I for a set of different ages along with the underlying realization value of the forest stand – for all cases where it is larger than zero. We see that the present value measure of the stand ranges from about 21.000 DKK/ha for the young stand to more than 385.000 DKK/ha for the mature stand. At any time the present value measure is well above the realization value and the ratio between the two develops from 10%-90%

Table 6: Oak, site class I, evaluated at 3% interest rate, with rotation 140 years

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	20,842	37,602	63,500	79,044	95,756	114,680	136,503	161,584	189,664	221,944
Realization Value in DKK	0	0	6,555	16,371	30,690	41,954	59,280	84,342	120,264	156,959
Ratio	0%	0%	10%	21%	32%	37%	43%	52%	63%	71%

Stand age	**105**	**115**	**125**	**135**
Present Value in DKK	257,314	296,768	338,559	385,924
Realization Value in DKK	197,895	243,914	298,630	346,409
Ratio	77%	82%	88%	90%

Similarly, Table 7 below presents the corresponding results for site class III and here we also see the lower values of present value measures of foregone income.

Table 7: Oak, site class III, evaluated at 3% interest rate, with rotation 160 years

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	-2,402	7,273	23,039	30,212	36,648	43,651	51,348	58,714	68,743	80,610
Realization Value in DKK	0	0	1,271	5,549	11,416	18,271	24,296	34,265	45,870	57,317
Ratio	0%	0%	1%	18%	31%	42%	47%	58%	67%	71%

Stand age	**105**	**115**	**125**	**135**	**145**	**155**
Present Value in DKK	94,475	110,272	128,746	148,948	173,512	210,477
Realization Value in DKK	71,038	87,807	108,637	136,239	168,360	207,412
Ratio	75%	80%	84%	91%	97%	99%

These calculations are also based on standard forest product assortments being harvested in thinnings as well as the final harvest. As was the case for Beech forests, it may also be the case for here, that forest stands offered up for setting aside as untouched will have a significantly lower average quality. To illustrate the consequences we present the results under the assumption that the log quality of the Oak forest is of C quality only. These results are shown in Table 8 for site class I evaluated at 3% interest rate.

Table 8: Oak, site class I, evaluated at 3% interest rate, with rotation 140 years, C quality

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	15,388	30,487	53,915	66,295	78,880	92,154	106,472	122,033	138,573	157,290
Realization Value in DKK	0	0	6,377	16,023	30,394	41,211	56,523	76,790	103,892	128,700
Ratio	0%	0%	12%	24%	39%	45%	53%	63%	75%	82%

Stand age	105	115	125	135
Present Value in DKK	177,414	200,070	224,354	253,159
Realization Value in DKK	153,613	179,094	207,053	230,382
Ratio	87%	90%	92%	91%

The lower quality influences both present and realization values and these are significantly lower compared to the values presented in Table 6 and the difference increases with stand age. Again, this illustrates the range of possible compensation needs even for this high site class.

In the Appendix (A10-A11), we present the same results of assuming C quality also in site class III. We also show these and all of the above tables in two different versions for interest rates 1% and 2%. In general, lower interest rates increase the present value of future income losses.

5.3 Alder

We assume that Alder is grown in a system of natural regeneration, and we modify the existing growth and management model for Alder to reflect this in a way similar to Beech. We apply a slightly larger thinning at the age of 60 to spur regeneration from stumps as well as seedlings and remove the over-story over 10 years. We further assume that regeneration happens at essentially no additional costs, but also assume that only one assortment is harvested and sold, and that is fire wood. Below in Table 9, we find the present value (at 3% interest rate) of an Alder forest stands for a set of different ages along with the underlying realization value of the forest stand – for all cases where it is larger than zero. We see here that the present value measure of the stand is always well above the realization value and that the ratio here in only in the range of 29% to 55%. The fairly short rotation age and the natural regeneration assumption drive this larger wedge between present value and realization value.

Table 9: Alder, evaluated at 3% interest rate, with 60 years rotation

Stand age	5	15	25	35	45	55
Present Value in DKK	41,634	49,505	59,265	54,386	53,886	51,657
Realization Value in DKK	13,787	14,315	23,275	28,273	29,486	28,290
Ratio	33%	29%	39%	52%	55%	55%

In Table 10 we also present a model where we apply a slightly faster regeneration at the age of 40, but otherwise make the same assumptions. We see here that the present value measures are slightly higher compared to when regenerated at the age of 60 and that they always are well above the realization value with a ratio in the range of 27% to 64%.

Table 10: Alder, evaluated at 3% interest rate, with 40 years rotation

Stand age	**5**	**15**	**25**	**35**
Present Value in DKK	45,873	53,180	55,740	67,124
Realization Value in DKK	29,486	14,315	23,275	28,273
Ratio	64%	27%	42%	42%

In the Appendix (A6), we present the results for the same models using two different versions of interest rates 1% and 2% for the rotation of 60 years and likewise for the shorter rotation in Appendix A15. In general, lower interest rates increase the present value of future income losses.

6. Caveats

The above calculated foregone income present value measures and realization value measures are all based on existing growth and forest management models of complete forest stands established and managed according to well-tested silvicultural standards. In any specific contexts several deviations from this ideal may occur, and here we discuss common examples and how they can be accounted for by approximations based on the above.

In many forest stands, the crown cover is not complete, often because areas of the stand are too wet for trees to grow and mature, hold ditches or similar, which reduces the crown cover below the 100 % implicitly assumed in the above models. In such cases, a first order approximation based on the above values is to reduce them proportionally to what is considered the productive crown cover ratio of the stand.

As we have shown, quality of the logs in the stand also affects its value. We have simulated a version where all logs are of C quality, however the log volume is kept constant. It is entirely possible that some stands have a lower log volume in addition to lower log quality, e.g. due to short bole lengths perhaps caused by low density of the stand in the early years. Such cases will again have lower present and realization values than listed above. Again, a rough first order correction would be to assess the realization value of the standing timber and make a proportional correction on top of that to account for the present value of foregone incomes. Lower quality and lower assortments translate to lower prices, and the present values as well as the realization value are roughly proportional to price levels (apart from the effect of e.g. regeneration costs).

As an additional deviating case we note, that sometimes stands offered for untouched forest land are also of considerably higher age than the above managed forests. Again, a rough approximation can be achieved by calculating the realization value and adding a premium corresponding to the modelled ratio of present value over realization value close to the optimal rotation age, and add this as a mark up to the observed realization value in the actual forest stand. On the other hand, Beech in these older stands might be subject to formation of red heartwood, which would imply that a more realistic approximation would be to calculate a markdown using the ratio between present values and realization values from the C quality tables.

A special point worthy of future attention is the issue of how much of the volume in a stand needs to be left for the biodiversity benefits to develop and be secured. As we see in the highly valuable mature stands of Beech and Oak, the realization value constitutes a considerable part of the present value of the

stand when close to the optimal rotation age. This means, that if the more valuable parts of volume can be harvested to the benefit or at least to no harm of biodiversity values, costs of setting aside forests as untouched could be considerably reduced in some cases. Such an analysis should draw upon models and knowledge of the decay of dead wood combined with assortment variation analyses, and recommendations should reflect uncertainty about long run impacts.

Finally we note that the use of standard models, standard assortment tables, standard establishment models, existing prices etc. of course imply some uncertainty in general. We have corrected as far as possible standard models to reflect current situations, e.g. adapted standard assortment models to the currently sold and dominating assortments in the market. These approximations may have some effects on the estimated present and realization values, but in general the effects are quite small as the growth models and the discounting predicts by far most of the variation in both value measures.

7. Concluding discussion

This report has calculated and presented costs of forgone income for forest owners in case the forest is set aside for biodiversity purposes, i.e. as untouched forest. The results are intended to inform the design of a support grant scheme to be designed and implemented to compensate private landowners for costs of voluntarily setting aside forestland as permanently untouched, which here implies the absence of any management activities.

We applied a standard present value approach to calculate present value measures of foregone income net of forest operation costs based on established models of forest growth and forest operations applied together with best available data on forest operation costs and forest product prices. Furthermore, we calculated the realization values of forest stands at different ages during the rotation.

We have presented results for three broadleaved forest types based on main forest species, which are Beech (*Fagus sylvatica*), Oak (*Querqus robur*) and Alder (*Alnus glutinosa*). Beech and Alder were assumed grown in forest systems applying natural regeneration, whereas Oak was assumed grown in clear cutting systems.

For Beech site class I evaluated at 3% interest rate, we find present values in the range between 73,000 to 173,000 DKK/ha over the stands life. The realization value is always lower ranging from 17% to 85% of the present value, highest when the stand is almost mature. Note, that also in the younger years we see quite high realization values due the natural regeneration system. For site class III, also evaluated at 3% interest rate, we find a lower range of present values, ranging from 35,000-108,000 DKK/ha and also here the realization values are consistently lower than the present values, approximately in the same range as for site class I. The lower productivity of site class V implies that the regeneration costs, which are assumed identical across the three site classes, weighs relatively heavier in the present value measures which drops to a range between 10,000 to 41,000 DKK/ha. Because of the low productivity combined with the relatively high interest rate at 3% we find ratios between present values and realization that are above 100% close to optimal rotation age. We note that these are not common forest types.

Forest stands offered as being set aside for biodiversity purposes might be of poor quality and therefore the report includes models where all logs are assumed to be of C quality. In that case we find that the present values and the realization values decrease considerably compared to forest stands at similar site classes and evaluated at similar interest rates. For Beech site class I, of C quality, evaluated at 3% interest rate the present values range between 66,000-142,000 DKK/ha, which illustrates the range of possible

compensation needs even for this high site class. We see a large variation in the ratio between present values and realization values ranging from 19% to 83%.

For Oak evaluated at 3% interest rate, we note that the soil expectation value is negative for all site classes due to the long production period and the high establishment costs. Therefore, a switch to Norway spruce following final harvest is assumed in the Oak models at this interest rate.

For site class I we see that the present value measure ranges from about 21,000 DKK/ha for the young stand to more than 385,000 DKK/ha for the mature stand. At any time the present value measure is well above the realization value and the ratio between the two develops from 0% to 90%. For Oak site class III also evaluated at 3% interest rate we also see lower values of present value measures of foregone income due to lower productivity. Present values range from -2,000 to 210,000 DKK/ha and the ratio between present values and realization value varies between 0% and 99%

Analogous to the calculations for Beech we also present models of low quality Oak stands where all logs are assumed to be of C quality. The lower quality influences both present and realization values and they are much lower compared to the values presented for the same site class and the difference increases with stand age. The present values for site class I evaluated at 3% interest rate ranges from -15,000 to 253,000 DKK/ha with the ratio between present values and realization values developing from 0% to 92%. Again, this illustrates the range of possible compensation needs even for this high site class if the quality is low.

For the results presented that relates to Alder we have modified the existing growth and management model in a way similar as for Beech in order to resemble the naturel regeneration, applying a slightly larger thinning at the age of 60 to spur regeneration from stumps as well as seedlings and remove the over-story over 20 years. We also assumed that regeneration happens at no costs and that the only assortment is harvested and sold as firewood. For the Alder models evaluated at 3% interest rate we find present values ranging from 42,000 to 59,000 DKK/ha and that the underlying realization value of the forest stand is always well below present values and that the ratio here is in the range of 29% to 55%. For a shorter rotation age of 40 years we find for the model evaluated at 3% the present values to range from 45,000 to 67,000 with the ration between present values and realization values to range from 27% to 64%. We find that especially the natural regeneration assumption drive this larger wedge between present value and realization value.

In the appendices, we show all three species and their related site classes evaluated at lower interest rates, i.e. 1% and 2%. In general, lower interest rates will increase the present value of future income foregone, but the interest rate does not affect the realization value, and therefore the ratio of this relative to present

values also decrease substantially for lower interest rates. Interest rates do affect the rotation age, however, and thus the range over which we consider present and realization values

Forest stands and their values will evidently vary a lot due to different circumstances. These could be incomplete crown cover, low quality logs, low volume or unusual high age of the stand. In such cases, a rough approximation can be achieved by calculating the realization value and adding a premium corresponding to the ratio of present value over realization value close to the optimal rotation age.

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Appendices

A1. Beech. Site class I

Table A1.1 Beech, Site class I. Evaluated at 1% interest rate, rotation 90/120

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	411,472	410,839	418,514	321,693	337,339	352,599	368,385	384,655	401,860
Realization Value in DKK	142,886	133,934	155,652	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	35%	33%	37%	11%	15%	23%	24%	30%	33%
Volume (m^3) *	390	342	295	148	205	310	318	386	407
Diameter (cm) *	47	52	57	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A1.2 Beech. Site class I. Evaluated at 2% interest rate. Rotation 90/110

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	229.738	231.844	124.907	145.392	157.358	169.711	183.587	199.215	217.418
Realization Value in DKK	142.886	133.934	12.766	34.735	51.917	82.167	89.052	117.029	132.645
Ratio	62%	58%	10%	24%	33%	48%	49%	59%	61%
Volume (m^3) *	390	342	65	148	205	310	318	386	407
Diameter (cm) *	47	52	9	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A1.3 Beech. Site class I. Evaluated at 3% interest rate. Rotation 90/110

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	172,952	179,288	73,310	90,950	100,317	110,445	122,753	137,874	157,262
Realization Value in DKK	142,886	133,934	12,766	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	83%	75%	17%	38%	52%	74%	73%	85%	84%
Volume (m^3) *	390	342	65	148	205	310	318	386	407
Diameter (cm) *	47	52	9	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

A2. Beech. Site class III

Table A2.1 Beech. Site class III. Evaluated at 1% interest rate. Rotation 100/140

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	251,500	252,808	260,808	258,104	190,730	201,180	210,018	219,343	229,539	240,052
Realization Value in DKK	87,350	80,660	76,110	73,494	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	35%	32%	29%	28%	14%	20%	23%	29%	33%	36%
Volume (m^3) *	273	230	193	157	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A2.2 Beech. Site class III. Evaluated at 2% interest rate. Rotation 100/140

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	138,365	141,072	151,607	151,713	84,097	92,024	98,704	106,361	115,582	125,994
Realization Value in DKK	87,350	80,660	76,110	73,494	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	63%	57%	50%	48%	32%	43%	49%	59%	66%	69%
Volume (m^3) *	273	230	193	157	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A2.3 Beech. Site class III. Evaluated at 3% interest rate. Rotation 100/120

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	102,848	107,797	35,196	44,750	52,002	58,322	63,525	69,984	78,538	89,123
Realization Value in DKK	87,350	80,660	2,608	12,366	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	85%	75%	7%	28%	52%	67%	76%	90%	97%	98%
Volume (m^3) *	230	193	17	64	112	159	187	234	271	294
Diameter (cm) *	44	50	6	9	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

A3. Beech. Site class V

Table A3.1 Beech. Site class V. Evaluated at 1% interest rate. Rotation 110/160

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	98,939	98,223	105,226	103,745	102,926	75,887	80,873	83,474	85,636	87,422	87,440
Realization Value in DKK	43,202	38,462	34,062	31,250	33,027	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	44%	39%	32%	30%	32%	19%	25%	34%	42%	47%	51%
Volume (m^3) *	160	136	116	98	82	70	92	120	147	162	169
Diameter (cm) *	27	31	34	37	39	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A3.2 Beech. Site class V. Evaluated at 2% interest rate. Rotation 110/140

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	54.310	53.991	61.722	24.840	29.808	34.317	38.573	40.554	42.182	43.505	42.958
Realization Value in DKK	43.202	38.462	34.062	995	6.659	14.123	20.423	28.410	36.344	41.304	44.222
Ratio	80%	71%	55%	4%	22%	41%	53%	70%	86%	95%	103%
Volume (m^3) *	160	136	116	7	38	70	92	120	147	162	169
Diameter (cm) *	27	31	34	5	8	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A3.3 Beech. Site class V. Evaluated at 3% interest rate. Rotation 110/130

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	40,674	41,271	10,177	13,678	17,861	21,778	25,675	27,376	28,795	29,972	29,173
Realization Value in DKK	43,202	38,462	0	995	6,659	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	106%	93%	0%	7%	37%	65%	80%	104%	126%	138%	152%
Volume (m^3) *	160	136	0	7	38	70	92	120	147	162	169
Diameter (cm) *	27	31	0	5	8	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

A4. Oak. Site class I

Table 4.1 Oak. Site class I. 1% interest rate. Rotation 170

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	284,128	319,471	363,553	396,414	429,280	462,678	496,604	530,589	563,504	595,377
Realization Value in DKK	0	0	6,555	16,371	30,690	41,954	59,280	84,342	120,264	156,959
Ratio	0%	0%	2%	4%	7%	9%	12%	16%	21%	26%
Volume (m^3) *	0	0	70	120	164	181	202	227	262	283
Diameter (cm) *	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**
Present Value in DKK	623,999	648,975	667,332	680,377	691,725	708,349	717,047
Realization Value in DKK	197,895	243,914	298,630	346,409	390,513	428,983	452,984
Ratio	32%	38%	45%	51%	56%	61%	63%
Volume (m^3)	296	304	310	316	321	326	330
Diameter(cm)	51	56	62	67	73	78	83

Table A4.2 Oak. Site class I. 2% interest rate. Rotation 150

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	70,077	93,282	125,471	147,239	169,984	194,503	221,119	249,711	279,460	310,774
Realization Value in DKK	0	0	6,555	16,371	30,690	41,954	59,280	84,342	120,264	156,959
Ratio	0%	0%	5%	11%	18%	22%	27%	34%	43%	51%
Volume (m^3)	0	0	70	120	164	181	202	227	262	283
Diameter (cm)	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**	**145**
Present Value in DKK	341,679	372,023	398,824	423,512	450,230
Realization Value in DKK	197,895	243,914	298,630	346,409	390,513
Ratio	58%	66%	75%	82%	87%
Volume (m^3)	296	304	310	316	321
Diameter (cm)	51	56	62	67	73

Table A4.3 Oak. Site class I. 3% interest rate. Rotation 140

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	20,842	37,602	63,500	79,044	95,756	114,680	136,503	161,584	189,664	221,944
Realization Value in DKK	0	0	6,555	16,371	30,690	41,954	59,280	84,342	120,264	156,959
Ratio	0%	0%	10%	21%	32%	37%	43%	52%	63%	71%
Volume (m^3)	0	0	70	120	164	181	202	227	262	283
Diameter (cm)	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**
Present Value in DKK	257,314	296,768	338,559	385,924
Realization Value in DKK	197,895	243,914	298,630	346,409
Ratio	77%	82%	88%	90%
Volume (m^3)	296	304	310	316
Diameter (cm)	51	56	62	67

A5. Oak. Site class III

Table A5.1 Oak. Site class III. 1% interest rate. Rotation 180

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	102,307	120,616	144,138	158,601	171,944	185,329	198,706	211,035	224,759	238,596
Realization Value in DKK			1,271	5,549	11,416	18,271	24,296	34,265	45,870	57,317
Ratio	0%	0%	1%	3%	7%	10%	12%	16%	20%	24%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**	**175**
Present Value in DKK	252,168	264,828	276,548	285,692	293,667	305,726	317,327	332,282
Realization Value in DKK	71,038	87,807	108,637	136,239	168,360	207,412	232,046	245,367
Ratio	28%	33%	39%	48%	57%	68%	73%	74%
Volume (m^3)	203	213	218	235	250	268	281	288
Diameter (cm)	35	39	43	47	51	55	57	58

Table A5.2 Oak. Site class III. 2% interest rate. Rotation 170

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	17,638	30,612	49,347	59,472	68,910	78,921	89,569	99,847	112,494	126,449
Realization Value in DKK			1,271	5,549	11,416	18,271	24,296	34,265	45,870	57,317
Ratio	0%	0%	3%	9%	17%	23%	27%	34%	41%	45%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**
Present Value in DKK	141.571	157.431	174.265	190.591	208.145	233.130	261.689
Realization Value in DKK	71.038	87.807	108.637	136.239	168.360	207.412	235.349
Ratio	50%	56%	62%	71%	81%	89%	90%
Volume (m^3)	203	213	218	235	250	268	285
Diameter (cm)	35	39	43	47	51	55	57

Table A5.3 Oak. Site class III. 3% interest rate. Rotation 160

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	-2,402	7,273	23,039	30,212	36,648	43,651	51,348	58,714	68,743	80,610
Realization Value in DKK			1,271	5,549	11,416	18,271	24,296	34,265	45,870	57,317
Ratio	0%	0%	6%	18%	31%	42%	47%	58%	67%	71%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**
Present Value in DKK	94,475	110,272	128,746	148,948	173,512	210,477
Realization Value in DKK	71,038	87,807	108,637	136,239	168,360	207,412
Ratio	75%	80%	84%	91%	97%	99%
Volume (m^3)	203	213	218	235	250	268
Diameter (cm)	35	39	43	47	51	55

A6. Alder

Table A6.1 Alder. 1% interest rate. Rotation 60

Stand age	**5**	**15**	**25**	**35**	**45**	**55**
Present Value in DKK	133,290	141,389	150,209	145,162	144,564	142,624
Realization Value in DKK	13,787	14,315	23,275	28,273	29,486	28,290
Ratio	10%	10%	15%	19%	20%	20%
Volume (m^3) *	107	111	181	220	229	220
Diameter (cm) *	30	8	14	19	23	27

*) The number only reflects the volume/diameter of the over-story

Table A6.2 Alder. 2% interest rate. Rotation 60

Stand age	**5**	**15**	**25**	**35**	**45**	**55**
Present Value in DKK	64,614	72,624	81,937	76,968	76,405	74,305
Realization Value in DKK	13,787	14,315	23,275	28,273	29,486	28,290
Ratio	21%	20%	28%	37%	39%	38%
Volume (m^3) *	107	111	181	220	229	220
Diameter (cm) *	30	8	14	19	23	27

*) The number only reflects the volume/diameter of the over-story

Table A6.3 Alder. 3% interest rate. Rotation 60

Stand age	**5**	**15**	**25**	**35**	**45**	**55**
Present Value in DKK	41,634	49,505	59,265	54,386	53,886	51,657
Realization Value in DKK	13,787	14,315	23,275	28,273	29,486	28,290
Ratio	33%	29%	39%	52%	55%	55%
Volume (m^3) *	107	111	181	220	229	220
Diameter (cm) *	30	8	14	19	23	27

*) The number only reflects the volume/diameter of the over-story

A7. Beech. Site class I. C quality logs

Table A7.1 Beech. Site class I. Evaluated at 1% interest rate, rotation 90/120. C-quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	328,685	329,570	339,146	268,499	278,417	287,494	297,036	307,179	318,660
Realization Value in DKK	113,396	103,131	126,206	35,027	51,606	79,106	81,847	101,913	111,068
Ratio	34%	31%	37%	13%	19%	28%	28%	33%	35%
Volume (m^3) *	390	342	295	148	205	310	318	386	407
Diameter (cm) *	47	52	57	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A7.2 Beech. Site class I. Evaluated at 2% interest rate. Rotation 90/11. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	182,882	185,960	109,270	126,312	133,918	141,119	149,360	158,968	170,986
Realization Value in DKK	113,396	103,131	12,810	35,027	51,606	79,106	81,847	101,913	111,068
Ratio	62%	55%	12%	28%	39%	56%	55%	64%	65%
Volume (m^3) *	390	342	65	148	205	310	318	386	407
Diameter (cm) *	47	52	9	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A7.3 Beech. Site class I. Evaluated at 3% interest rate. Rotation 90/110. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	136,156	142,222	66,407	81,652	87,623	93,364	100,487	109,579	122,134
Realization Value in DKK	113,396	103,131	12,810	35,027	51,606	79,106	81,847	101,913	111,068
Ratio	83%	73%	19%	43%	59%	85%	81%	93%	91%
Volume (m^3)	390	342	65	148	205	310	318	386	407
Diameter (cm)	47	52	9	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

A8. Beech. Site class III. C quality logs

Table A8.1 Beech. Site class III. Evaluated at 1% interest rate. Rotation 100/140. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	203,293	204,321	212,790	211,294	161,251	168,530	173,909	179,560	185,962	192,694
Realization Value in DKK	73,817	65,313	59,753	58,450	27,380	39,381	47,477	59,789	69,774	76,993
Ratio	36%	32%	28%	28%	17%	23%	27%	33%	38%	40%
Volume (m^3) *	273	230	193	157	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A8.2 Beech. Site class III. Evaluated at 2% interest rate. Rotation 100/140. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	110,799	112,726	123,169	123,923	73,901	79,500	83,389	87,808	93,371	99,778
Realization Value in DKK	73,817	65,313	59,753	58,450	27,380	39,381	47,477	59,789	69,774	76,993
Ratio	67%	58%	49%	47%	37%	50%	57%	68%	75%	77%
Volume (m^3) *	273	230	193	157	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A8.3 Beech. Site class III. Evaluated at 3% interest rate. Rotation 100/120. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	82,690	86,502	32,686	41,408	47,485	52,147	55,174	58,888	64,074	70,630
Realization Value in DKK	73,817	65,313	2,570	12,396	27,380	39,381	47,477	59,789	69,774	76,993
Ratio	89%	76%	8%	30%	58%	76%	86%	102%	109%	109%
Volume (m^3) *	230	193	17	64	112	159	187	234	271	294
Diameter (cm) *	44	50	6	9	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

A9. Beech. Site class V. C quality logs

Table A9.1 Beech. Site class V. Evaluated at 1% interest rate. Rotation 110/160. C-quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	87.392	86.335	93.223	91.867	91.377	69.372	73.671	75.476	76.741	77.549	76.548
Realization Value in DKK	40.996	35.179	30.234	27.036	28.914	14.193	20.603	28.636	36.421	40.920	43.040
Ratio	47%	41%	32%	29%	32%	20%	28%	38%	47%	53%	56%
Volume (m^3) *	160	136	116	98	82	70	92	120	147	162	169
Diameter (cm) *	27	31	34	37	39	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A9.2 Beech. Site class V. Evaluated at 2% interest rate. Rotation 110/150. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	48,622	48,013	55,720	23,606	28,317	32,518	36,373	37,825	38,790	39,317	37,869
Realization Value in DKK	40,996	35,179	30,234	974	6,631	14,193	20,603	28,636	36,421	40,920	43,040
Ratio	84%	73%	54%	4%	23%	44%	57%	76%	94%	104%	114%
Volume (m^3) *	160	136	116	98	38	70	92	120	147	162	169
Diameter (cm) *	27	31	34	37	8	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A9.3 Beech. Site class V. Evaluated at 3% interest rate. Rotation 110/130. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	36.505	36.718	9.863	13.255	17.309	21.055	24.696	26.008	26.885	27.347	25.663
Realization Value in DKK	40.996	35.179	0	974	6.631	14.193	20.603	28.636	36.421	40.920	43.040
Ratio	112%	96%	0%	7%	38%	67%	83%	110%	135%	150%	168%
Volume (m^3) *	160	136		7	38	70	92	120	147	162	169
Diameter (cm) *	27	31		5	8	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

A10. Oak. Site class I. C quality logs

Table A10.1 Oak. Site class I. 1% interest rate. Rotation 170. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	195,637	222,690	256,627	278,411	299,143	319,052	338,151	356,222	372,590	387,783
Realization Value in DKK	0	0	6,377	16,023	30,394	41,211	56,523	76,790	103,892	128,700
Ratio	0%	0%	2%	6%	10%	13%	17%	22%	28%	33%
Volume (m^3)	0	0	70	120	164	181	202	227	262	283
Diameter (cm)	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**
Present Value in DKK	400,432	410,797	417,180	421,081	425,189	434,014	400,432
Realization Value in DKK	153,613	179,094	207,053	230,382	250,814	267,828	153,613
Ratio	38%	44%	50%	55%	59%	62%	38%
Volume (m^3)	296	304	310	316	321	326	296
Diameter (cm)	51	56	62	67	73	78	51

Table A10.2 Oak. Site class I. 2% interest rate. Rotation 150. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	53,460	73,422	101,241	117,824	134,361	151,219	168,575	186,393	204,147	222,603
Realization Value in DKK	0	0	6,377	16,023	30,394	41,211	56,523	76,790	103,892	128,700
Ratio	0%	0%	6%	14%	23%	27%	34%	41%	51%	58%
Volume (m^3)	0	0	70	120	164	181	202	227	262	283
Diameter (cm)	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**	**145**
Present Value in DKK	240,540	258,422	274,630	290,913	310,538
Realization Value in DKK	153,613	179,094	207,053	230,382	250,814
Ratio	64%	69%	75%	79%	81%
Volume (m^3)	296	304	310	316	321
Diameter (cm)	51	56	62	67	73

Table A10.3 Oak. Site class I. 3% interest rate. Rotation 140. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	15,388	30,487	53,915	66,295	78,880	92,154	106,472	122,033	138,573	157,290
Realization Value in DKK	0	0	6,377	16,023	30,394	41,211	56,523	76,790	103,892	128,700
Ratio	0%	0%	12%	24%	39%	45%	53%	63%	75%	82%
Volume (m^3)	0	0	70	120	164	181	202	227	262	283
Diameter (cm)	0	0	11	16	22	26	31	36	41	46

Stand age	**105**	**115**	**125**	**135**
Present Value in DKK	177,414	200,070	224,354	253,159
Realization Value in DKK	153,613	179,094	207,053	230,382
Ratio	87%	90%	92%	91%
Volume (m^3)	296	304	310	316
Diameter (cm)	51	56	62	67

A11. Oak. Site class III. C-quality logs

Table A11.1 Oak. Site class III. 1% interest rate. Rotation 180. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	75,148	90,913	111,327	122,287	131,888	141,215	150,092	157,425	165,633	173,494
Realization Value in DKK		0	1,387	5,433	11,097	17,954	24,053	33,823	44,607	54,512
Ratio	0%	0%	1%	4%	8%	13%	16%	21%	27%	31%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**	**175**
Present Value in DKK	180,738	186,896	192,146	195,323	197,900	204,164	210,168	218,880
Realization Value in DKK	65,518	77,971	91,792	110,296	130,402	153,996	168,866	176,833
Ratio	36%	42%	48%	56%	66%	75%	80%	81%
Volume (m^3)	203	213	218	235	250	268	281	288
Diameter (cm)	35	39	43	47	51	55	57	58

Table A11.2 Oak. Site class III. 2% interest rate. Rotation 170. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	12,905	24,956	42,452	50,991	58,634	66,540	74,604	81,706	90,481	99,847
Realization Value in DKK			1,387	5,433	11,097	17,954	24,053	33,823	44,607	54,512
Ratio	0%	0%	3%	11%	19%	27%	32%	41%	49%	55%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**	**165**
Present Value in DKK	141,571	157,431	174,265	190,591	208,145	233,130	261,689
Realization Value in DKK	109,677	119,624	130,037	139,836	150,753	167,830	187,638
Ratio	65.518	77.971	91.792	110.296	130.402	153.996	171.269
Volume (m^3)	60%	65%	71%	79%	87%	92%	91%
Diameter (cm)	203	213	218	235	250	268	285

Table A11.3 Oak. Site class III. 3% interest rate. Rotation 160. C quality logs

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	-3,604	5,705	20,932	27,295	32,798	38,637	44,750	49,957	57,087	65,200
Realization Value in DKK			1,387	5,433	11,097	17,954	24,053	33,823	44,607	54,512
Ratio	0%	0%	7%	20%	34%	46%	54%	68%	78%	84%
Volume (m^3)	0	0	27	66	98	124	135	159	179	192
Diameter (cm)	0	0	6	10	13	17	21	25	28	32

Stand age	**105**	**115**	**125**	**135**	**145**	**155**
Present Value in DKK	74,354	84,412	96,041	108,478	124,060	149,157
Realization Value in DKK	65,518	77,971	91,792	110,296	130,402	153,996
Ratio	88%	92%	96%	102%	105%	103%
Volume (m^3)	203	213	218	235	250	268
Diameter (cm)	35	39	43	47	51	55

A12. Beech. Site class I. Accelerated harvest of over-story

Table A12.1 Beech, Site class I. Evaluated at 1% interest rate, rotation 90/12. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	393,958	376,143	361,860	313,306	328,075	342,365	357,080	372,168	388,066
Realization Value in DKK	148,957	117,849	84,683	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	38%	31%	23%	11%	16%	24%	25%	31%	34%
Volume (m^3)*	406	301	187	148	205	310	318	386	407
Diameter (cm)*	47	52	57	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A12.2 Beech. Site class I. Evaluated at 2% interest rate. Rotation 90/110. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	224,201	202,842	124,410	144,787	156,620	168,811	182,490	197,878	215,788
Realization Value in DKK	147,723	110,550	12,766	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	66%	55%	10%	24%	33%	49%	49%	59%	61%
Volume (m^3) *	402	282	187	148	205	310	318	386	407
Diameter (cm) *	47	52	57	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

Table A12.3 Beech. Site class I. Evaluated at 3% interest rate. Rotation 90/110. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**
Present Value in DKK	171,810	153,220	73,636	91,389	100,907	111,237	123,818	139,306	159,186
Realization Value in DKK	147,723	110,550	12,766	34,735	51,917	82,167	89,052	117,029	132,645
Ratio	86%	72%	17%	38%	51%	74%	72%	84%	83%
Volume (m^3) *	402	282	65	148	205	310	318	386	407
Diameter (cm) *	47	52	9	15	20	25	31	36	40

*) The number only reflects the volume/diameter of the over-story

A13. Beech. Site class III. Accelerated harvest of over-story

Table A13.1 Beech. Site class III. Evaluated at 1% interest rate. Rotation 100/14. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	206,550	197,004	191,170	184,624	168,189	176,280	182,513	188,959	195,977	202,979
Realization Value in DKK	82,478	65,802	45,771	38,503	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	40%	33%	24%	21%	16%	22%	26%	33%	39%	43%
Volume (m^3) *	258	188	113	67	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A13.2 Beech. Site class III. Evaluated at 2% interest rate. Rotation 100/130. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	117,356	108,674	103,291	96,615	78,974	85,780	91,091	97,082	104,270	112,205
Realization Value in DKK	81,761	65,699	44,693	12,366	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	70%	60%	43%	13%	34%	46%	53%	65%	73%	78%
Volume (m^3) *	258	188	113	67	112	159	187	234	271	294
Diameter (cm) *	39	44	50	56	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

Table A13.3 Beech. Site class III. Evaluated at 3% interest rate. Rotation 100/120. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Present Value in DKK	88,880	81,542	34,398	43,678	50,561	56,385	60,922	66,486	73,838	82,805
Realization Value in DKK	81,402	64,354	2,608	12,366	27,237	39,336	48,315	62,668	76,007	87,267
Ratio	92%	79%	8%	28%	54%	70%	79%	94%	103%	105%
Volume (m^3) *	254	184	17	64	112	159	187	234	271	294
Diameter (cm) *	39	44	6	9	17	18	22	26	31	35

*) The number only reflects the volume/diameter of the over-story

A14. Beech. Site class V. Accelerated harvest of over-story

Table A14.1 Beech. Site class V. Evaluated at 1% interest rate. Rotation 110/160. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	85,321	80,204	81,022	79,461	77,791	67,992	72,152	73,841	74,994	75,668	74,456
Realization Value in DKK	43,991	34,387	23,491	20,138	20,441	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	52%	43%	29%	25%	26%	21%	28%	38%	48%	55%	59%
Volume (m^3) *	163	122	80	62	43	70	92	120	147	162	169
Diameter (cm) *	27	31	34	37	39	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A14.2 Beech. Site class V. Evaluated at 2% interest rate. Rotation 110/160. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	48,690	43,856	45,104	43,903	42,502	32,373	36,202	37,664	38,660	39,211	37,724
Realization Value in DKK	43,991	34,387	23,491	20,138	20,441	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	90%	78%	52%	46%	48%	44%	56%	75%	94%	105%	117%
Volume (m^3) *	163	122	80	62	43	70	92	120	147	162	169
Diameter (cm) *	27	31	34	37	39	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

Table A14.3 Beech. Site class V. Evaluated at 3% interest rate. Rotation 110/130. Accelerated harvest

Stand age	**5**	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**	**105**
Present Value in DKK	33,239	28,671	9,838	13,221	17,248	20,955	24,567	25,888	26,795	27,284	25,561
Realization Value in DKK	40,653	31,034	0	995	6,659	14,123	20,423	28,410	36,344	41,304	44,222
Ratio	122%	108%	0%	8%	39%	67%	83%	110%	136%	151%	173%
Volume (m^3) *	151	110	0	7	38	70	92	120	147	162	169
Diameter (cm) *	27	31	0	5	8	10	12	15	18	21	24

*) The number only reflects the volume/diameter of the over-story

A15. Alder. Short rotation.

Table A15.1 Alder. 1% interest rate. Rotation 40 years

Stand age	**5**	**15**	**25**	**35**
Present Value in DKK	151,133	158,843	161,587	172,093
Realization Value in DKK	29,486	14,315	23,275	28,273
Ratio	20%	9%	14%	16%
Volume (m^3) *	229	111	181	220
Diameter (cm) *	30	8	14	19

*) The number only reflects the volume/diameter of the over-story

Table A15.2 Alder. 2% interest rate. Rotation 40 years

Stand age	**5**	**15**	**25**	**35**
Present Value in DKK	72,174	79,686	82,351	93,323
Realization Value in DKK	29,486	14,315	23,275	28,273
Ratio	41%	18%	28%	30%
Volume (m^3) *	229	111	181	220
Diameter (cm) *	23	8	14	19

*) The number only reflects the volume/diameter of the over-story

Table A15.3 Alder. 3% interest rate. Rotation 40 years

Stand age	**5**	**15**	**25**	**35**
Present Value in DKK	45,873	53,180	55,740	67,124
Realization Value in DKK	29,486	14,315	23,275	28,273
Ratio	64%	27%	42%	42%
Volume (m^3)*	229	111	181	220
Diameter (cm)*	23	8	14	19

*) The number only reflects the volume/diameter of the over-story

A16. Soil Expectation Values for Norway Spruce. Site class I

Table A16.1 Norway Spruce. Site class I evaluated at 1% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**
Soil Expectation Value	21,620	88,752	127,735	140,519	143,124	144,993

Table A16.2 Norway Spruce. Site class I evaluated at 2% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**
Soil Expectation Value	-10,671	16,596	31,003	35,053	35,481	35,630

Table A16.3 Norway Spruce. Site class I evaluated at 3% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**
Soil Expectation Value	-21,418	-6,843	56	1,612	1,531	1,357

A17. Soil Expectation Values for Norway Spruce. Site class III

Table A17.1 Norway Spruce. Site class III evaluated at 1% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Soil Expectation Value	-36,056	-1,984	28,849	5,994	66,185	72,489	73,101

Table A17.2 Norway Spruce. Site class II evaluated at 2% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Soil Expectation Value	-32,534	-18,001	-6,019	2,504	6,659	8,354	8,301

Table A17.3 Norway Spruce. Site class III evaluated at 3% interest rate

Rotation age	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Soil Expectation Value	-31,576	-23,407	-17,314	-13,431	-11,794	-11,272	-11,417